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CONSERVATION AND NATURAL HISTORY

Lost Iguanas: Trouble in Paradise

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Photographs by Victor Hugo Reynoso, unless otherwise stated.

Hispaniola is second only to Cuba in size and biodiversity among West Indian islands, and is unique in being the only island with two native species of Rock Iguanas, the Rhinoceros Iguana (*Cyclura cornuta*; Fig. 1) and Ricord's Iguana (*C. ricordii*). The island's geologic history is likely responsible. Hispaniola was formed during the middle Miocene when North and South paleoislands joined (Graham 2003). A logical hypothesis suggests that each paleoisland held one species, and when the two islands joined, the ranges of both species shifted, eventually resulting in the distributions seen today. *Cyclura ricordii* is restricted to the southwestern Dominican Republic (DR) and just across the southern border into Haiti, whereas *C. cornuta* has a larger distribution throughout much of the arid lowlands across the entire island.

According to IUCN Red List Assessments (Ottenwalder 1996a, 1996b), both species are threatened by habitat destruction, competition with invasive mammalian herbivores, predation by introduced mammalian predators, and poaching. *Cyclura ricordii* is listed as Critically Endangered (Ottenwalder 1996b), and has been the subject of considerable attention by conservation biologists in the recent past (e.g., Rupp et al. 2009, Rupp 2010). *Cyclura cornuta*, currently listed as Vulnerable (Ottenwalder 1996a), was thought to be more stable, in part because of its wide distribution; however, populations may be declining dramatically. Recent

Fig. 1. The Rhinoceros Iguana (*Cyclura cornuta*) is endemic to Hispaniola, the only island with two species of Rock Iguanas. Photograph by Stesha A. Pasachnik.

surveys by the authors indicated that the majority of *C. cornuta* populations outside of the southwestern DR are struggling. Multiple diurnal surveys at numerous locations resulted in no sightings or very scarce signs of iguanas. In addition, a new and unique threat is appearing — the iguanario (Fig. 2).

The first iguanario or iguana breeding facility was established in 1997 at the tourist attraction known as Manati Park, in Bavaro, in the southeastern DR. Given the financial success of this facility at bringing in tourists, similar establishments were eventually established across much of the country. Manati Park itself holds hundreds of iguanas of various age classes and has been referred to in the literature as an "iguana factory" (Powell et al. 2002). Iguana populations at other facilities number from the hundreds to just a few individuals at hotels (Fig. 3). The original purpose for the iguanarios was to help conserve Rhinoceros Iguanas by creating breeding groups that would be able to supplement diminishing wild populations, and aid in research and education efforts (Powell et al. 2002). Unfortunately, the situation has taken a turn for the worse. Because the iguanas live under natural conditions in these facilities, breeding is extensive even with very little human intervention. Many facilities are now grossly overpopulated, and no systematic release programs exist for the country or at individual facilities. In addition, the employee turnover rate at these iguanarios is such that most current employees are unaware of the original goals, and have very little historical information about their facilities and the animals.

In many cases the cycle begins when iguanas are confiscated from individuals who are attempting to sell them, which is illegal in the DR (Environmental Law 64-00). Once confiscated, iguanas are brought to the National Zoo in Santo Domingo (ZooDom), usually with little or no locality data. By 2009, ZooDom reported having 250 *C. cornuta* as a result of confiscations (http://www.listindiario.com/la-vida/2009/6/1/103245/Peligro-acecha-a-las-iguanas). Their facilities (Fig. 4) probably should not have had more than 20 individuals at one time. At ZooDom, individuals are not marked to allow individual identification or tracking. They are simply placed in large enclosures where they often breed,

Fig. 2. Sign pointing to the iguanario located in Los Tocones, Samana.

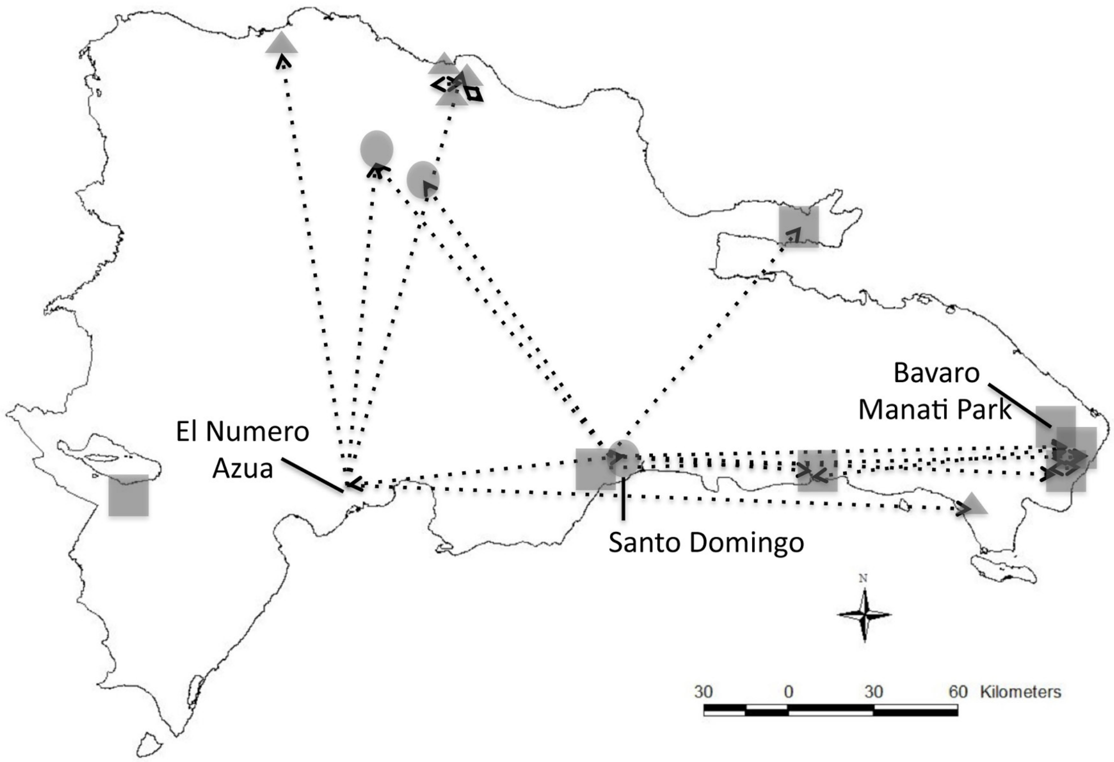

Fig. 3. Iguanarios holding Rhinoceros Iguanas (*Cyclura cornuta*) in the Dominican Republic as of 2013. Arrows indicate trafficking or movement patterns of captive individuals to the best of our knowledge. Circles indicate zoos, squares are large-scale facilities, and triangles are small-scale facilities.

thus diluting any potential genetic locality signatures that may have existed. This constant influx of iguanas placed ZooDom in a very difficult position, and many of the iguanas were and are farmed out to other facilities. Some iguanarios were even created for the sole purpose of relieving ZooDom of excess animals. In other instances, iguanas were released into the wild (i.e., 150 individuals were released in 2001; Secretaria de Estado de Medio Ambiente y Recursos Naturales 2001). In both cases, iguanas were moved or released with no consideration for their origins and without any identification records.

This scenario has been ongoing for some time. The original stock for larger facilities, such as the Manati Park iguanario, was ZooDom (Secretaria de Estado de Medio Ambiente y Recursos Naturales 2004). Many of the smaller organizations simply purchased their iguanas from locals. Complicating things further, some facilities mixed individuals from ZooDom with those purchased from locals and with anonymous iguana drop-offs from unknown locations. In most cases, whether through confiscation or purchase, iguanas likely originated from known poaching hot spots near Azua in the southern DR, although hard evidence is lacking, as poaching is illegal. In the area around Azua, the roadside location "El Numero," is widely known for the trade in animals, and is a probable source for many of the iguanas in circulation. Furthermore, iguanas also are traded between iguanarios, and hatchlings in particular are not managed and often escape haphazardly. Consequently, no records are associated with any of these individuals as they move from one location to the next, where they breed randomly and often escape or are released.

In short, the situation is purely chaotic, and the paths iguanas have taken to get to where they are now, with what individuals they have bred, and which individuals have been released into the wild are unknown. At this time, simply too

Fig. 4. One of the two Rhinoceros Iguana (*Cyclura cornuta*) holding pens at the National Zoo (ZooDom) in Santo Domingo, Dominican Republic. Photograph by Stesha A. Pasachnik.

Fig. 5. Two captive adult male Rhinoceros Iguanas (*Cyclura cornuta*) in combat.

many captive *C. cornuta* exist in the DR with few or any plans for them or the species. In addition, new iguanarios are opening all the time in hopes of turning a profit or relieving stress from another overcrowded facility. Although the original concept might have been well meaning or implemented simply to

Fig. 6. Small pen overflowing with hatchling Rhinoceros Iguanas (*Cyclura cornuta*). The owners did not know what they were going to do with all the hatchlings, and thus they were likely to be released into the wild or traded to another facility.

Fig. 7. Overcrowded adult Rhinoceros Iguana (*Cyclura cornuta*) pen.

address an already dire situation, the consequences are posing a real threat to the species.

Two main areas are of concern. The first focuses on the health and wellbeing of these iguanas. Captive animals often are exposed to diseases. Moving them from one location to another only increases that possibility, while simultaneously increasing the likelihood of spreading diseases (Jacobson

1993, Ippen and Zwart 1996). In addition, the now common overcrowding within the larger facilities causes individuals, primarily large males, to fight and often injure one another (Pratt et al. 1992; Figs. 4–7). Enclosures frequently provide inadequate den spaces and escapes are common, especially by smaller individuals. In addition, diets provided at many sites are very poor, frequently consisting of kitchen scraps (Fig. 8), far from what is recommended for *Cyclura* in captivity

Fig. 8. Examples of a typical diet of kitchen leftovers, consisting of fruit peels and pieces of meat.

(Lemm and Alberts 2011). In short, husbandry efforts need to be vastly improved.

The second main concern is more complicated, revolving around the concept of outbreeding depression. Outbreeding depression is the reduction in fitness due to the crossing of individuals from different populations. One of the best-known examples of this is the case of the Tatra Mountain Ibex (*Capra ibex ibex*). In an effort to save the Czechoslovakian population, which was on the brink of extinction due to overharvesting, Ibex from Turkey and Sinai were brought in to supplement the population. However, the resulting hybrids rutted in the fall instead of the winter, and the kids were born in the coldest part of the year. In other words, the population was now behaving like the introduced individuals and thus had lost their temporal adaptations, in turn resulting in the extirpation of the population (Templeton 1986). Marshall and Spalton (2000) discussed a similar situation in which the Arabian Oryx (*Oryx leucoryx*), designated extinct in the wild, was crossed with individuals from nearby populations, resulting in reduced juvenile survival. Other well-known examples of outbreeding depression are the Velvet Worms (Onychophora; Sunnucks and Tait 2001) and the Corroboree Frogs of Australia (*Pseudophryne* spp.; Osborne and Normal 1991). In both cases, hybrid populations have higher levels of abnormalities and thus reduced fitness (hybrid breakdown).

Outbreeding depression is most common when populations have been isolated for sufficiently long periods that local adaptations have arisen. This often occurs when substantial barriers, such as mountain ranges and bodies of water, block migration. The DR is replete with such features (Fig. 9), which are known barriers to dispersal. The north and south paleoisland boundary, known as the Cul-de-Sac-Enriquillo depression, has been submerged multiple times and as recently as the late Pleistocene (Graham 2003). The DR also has the highest peak in the West Indies, Pico Duarte (3,087 m asl), which is part of the Cordillera Central System. This system is a Cretaceous-Eocene island arc-terrane that emerged during the Miocene by an obligate convergence effect caused by the Caribbean and North American tectonic plates (Heubeck and Mann 1991). Although these are the most noteworthy, additional barriers (Fig. 9) also must be considered. Moving and mixing individuals of any species across these barriers could have substantial negative effects on the fit-

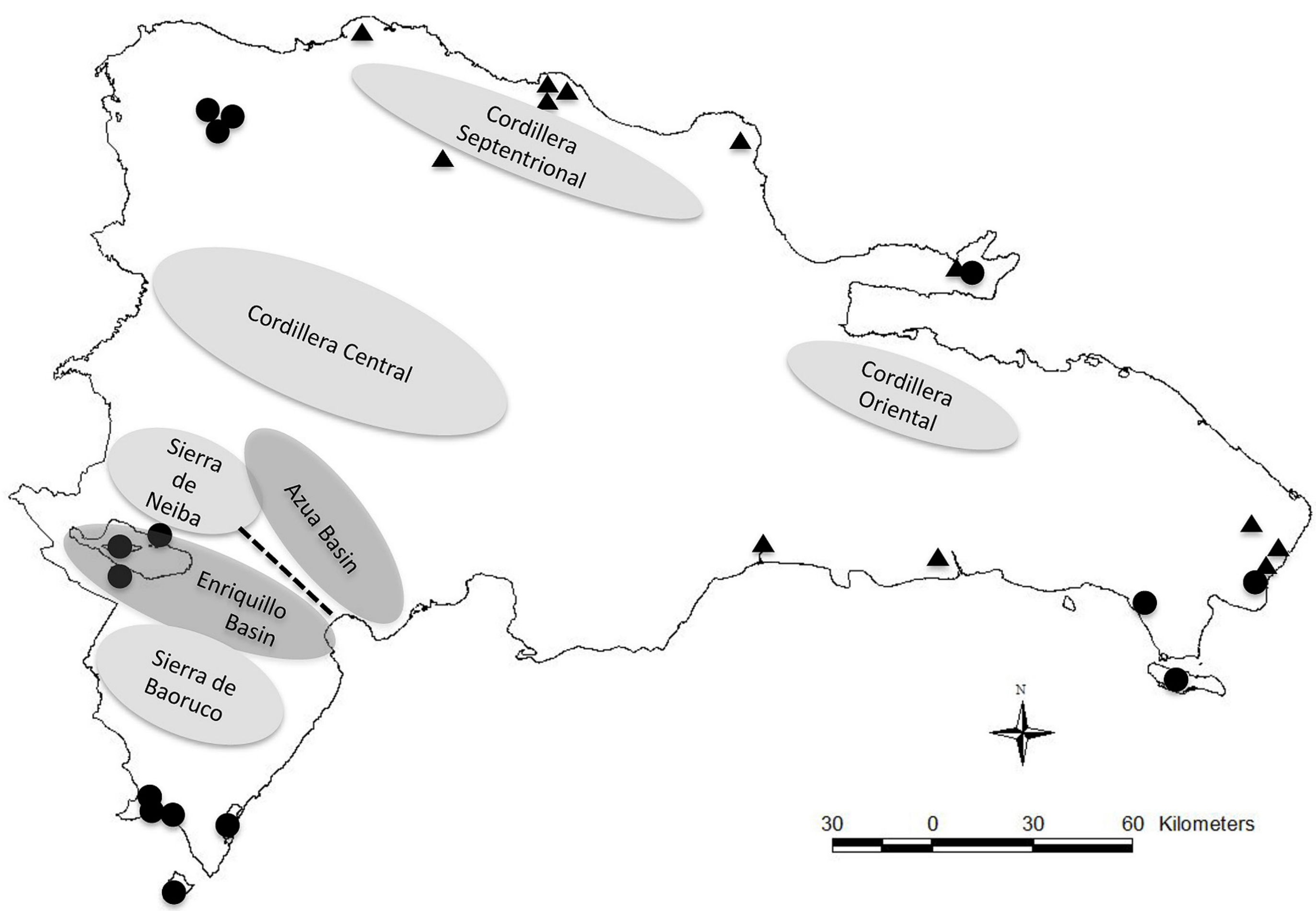

Fig. 9. Geographic barriers in the Dominican Republic. Lighter circles represent mountain ranges, darker circles basins. The dotted line represents the juncture of the paleoislands. Sampling locations from 2012 and 2013 are depicted with circles indicating natural populations and triangles marking captive samples taken from various facilities.

ness of the species, as differentiation of populations on opposite sides of the barrier is likely.

Many studies have elucidated just this type of divergence across geographic barriers within the DR. Gifford et al. (2004) conducted an extensive evaluation of the Hispaniolan Ground Lizard (*Ameiva chrysolaema*), which demonstrated the isolating effects of the Cordillera Central and Sierra de Bahoruco. They found a 14-percent genetic differentiation between populations, indicative of separation between populations for approximately 10 million years. This classic north-south divide also can be seen in the Hispaniolan Hutia (*Plagiodontia aedium*), with isolated populations demonstrating a differentiation of 3% (Brace et al. 2012), and species of Chat-Tanagers (*Calyptophilus*), with 21.9–25.7% differentiation between north and south island populations (Townsend et al. 2007). The Hispaniolan Boa (*Epicrates striatus*) shows a similar pattern across the Azua basin in the southwestern DR (Reynolds and Pasachnik, in prep.), and *Cyclura ricordii* shows a 23% differentiation between populations across the Sierra de Bahoruco (Carreras De Leon et al., in prep.).

The central theme that unites these studies is that the unique geological history of Hispaniola originating from two paleoislands and the presence of substantial mountain ranges have isolated populations of many species. These same barriers are likely to have had similar effects on other species, especially those with wide distributions on opposite sides of barriers. Given that *Cyclura cornuta* was at least historically present throughout most Hispaniolan lowlands, local adaptation of populations is probable. In an effort to better understand the population structure of *C. cornuta* across the DR, we have collected samples from numerous populations (Fig. 9) across various known dispersal barriers, and are in the process of analyzing them to assess levels of differentiation between populations. These data, which will show what populations should remain isolated, will be used to develop a suitable strategy for the proper conservation of the species. In the meantime, iguanarios should be managed much more closely and movement of individual iguanas curtailed, as the historic and current haphazard releases and relocations of individuals likely are detrimental to the preservation of the species.

Fig. 10. Although Rhinoceros Iguanas (*Cyclura cornuta*) are threatened, remnant populations exist around the country, and some populations in the south are thriving. Photograph by Lauren Anderson.

The goal of any conservation strategy is to minimize the risk of extinction. In allowing and even planning for the movement of individuals from distant populations, that goal is jeopardized. Given what we know about the range of *Cyclura cornuta* and the potential dispersal barriers, the conservative approach is to allow populations to remain in isolation and protect them as such, in order to conserve the species as a whole until the genetic data are available. Specifically, moving individuals from far points of the island should be avoided at all costs. For example, moving individuals from a captive setting in the southeast (Bavaro) to the wild in the northwest (Monte Cristi), as has been proposed, is the worst possible scenario. Released iguanas will have crossed many barriers that would normally preclude gene flow, and the chance of spreading disease is great. The threat to the natural population is heightened in this case by the fact that no iguanarios have ever operated in the northwestern DR; consequently, the natural population in that region is likely one of the very few pristine populations left in the entire nation.

Furthermore, given the status of *C. cornuta,* managing a captive breeding and release program is premature at best. Instead, immediate management priorities should target the prevention of trade and poaching of iguanas, along with the critical conservation and protection of natural habitats that are constantly being destroyed for various types of development. Captive breeding and translocation programs should be last-resort scenarios, and conservation of *C. cornuta* has yet to reach that stage. Although the species is threatened, remnant populations exist around the country, and some populations in the south are thriving (Fig. 10). Moving individuals from one location to another without a proper understanding of the genetic structure of the species is likely counterproductive and should be curtailed. Haphazardly translocating individuals actually could accelerate the rate of extinction. At the very least, extirpation of local populations through the introduction of disease and or the loss of local adaptations is likely.

In June 2014, the International Iguana Foundation and the Institute for Conservation Research, San Diego Zoo Global, along with local counterparts, Grupo Jaragua, the Ministry of the Environment, and ZooDom, will host a week-long workshop to address these issues with staffs of the various iguanarios. Iguana specialists from around the world will attend and participate in roundtable discussions and demonstrations. We hope that facilitating such an event will allow for the development of an appropriate management strategy for the species.

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